Photo by Anette Ask, Forsvaret

“Advances in medical intelligence and technologies require the ability to identify and assess the risk of biothreats globally and in real-time.”

THE GLOBAL BIOSURVEILLANCE PORTAL

A One Health Approach

by **COLONEL PAUL O. KWON**
U.S. Army Medical Corps
Director, U.S. Army Medical Research Directorate – Georgia

co-authors **BRENT BUTOWSKY**
International Lead, Global Biosurveillance Portal
MICHAEL E. MCCOWN
Deputy Director, U.S. Army Medical Research Directorate – Georgia

EMERGING INFECTIOUS DISEASES (EIDs) are significant risk to both military and civilian populations affecting social, political, environmental and economic outcomes. With new emerging human infections recognized yearly, certain encounters with endemic pathogens can impact the readiness and lethality of military operations as well as adversely impact global health and economies.[1,2] Additionally, advances in biotechnology and genetic engineering has enhanced the threat of bioweapon capabilities utilizing existing bacteria, viruses, and toxins.[3] As biowarfare development proliferates among many state and non-state actors, the landscape of an irregular battlefield continues to challenge the strategic and tactical leader.[2,4] Therefore, advances in medical intelligence and technologies require the ability to identify and assess the risk of biothreats globally and in real-time.

Historically, infectious diseases and outbreaks have been known to impact socio-economic stability. For example, the SARS ($54 billion)[5] and Ebola ($4.5 billion)[6] outbreaks revealed critical shortcomings within laboratory and public health infrastructure. Yearly, the seasonal influenza virus affects up to 5-20% of the U.S. population and burdens the healthcare system with over 960,000 hospitalizations and up to 79,000 deaths according to the 2017-18 flu burden from the Centers for Disease Control and Prevention.[7] Understanding the dynamics of disease detection and risk forecasting is therefore essential for outbreak prevention and mitigation strategies.

As a result, the United States' strategy for improved interagency support on EID efforts created the 1997 Presidential Directive and the Global Health Security Agenda with updated National Health Security Strategies (2019-22).[8] This provided a common vision and strategic direction as a unified effort based on evidence and collaboration. Also, the International Health Regulations (2005) legally guided international member states of the World Health Organization (WHO) to "detect, assess, and report" potential outbreaks and other public health emergencies.[9] As a policy framework towards research, the 2010 National Strategy for Countering Biothreats and the 2012 National Strategy for Biosurveillance directives emphasized timely and accurate information on current and emerging pathogens.[2] Based on these emerging and high-cost EIDs, there is a need for an integrated health surveillance and response programme, which has a real-time global outreach.

Future considerations of non-traditional data sources such as the internet, news, social media, smart phone application has also proven useful towards predictable EID models.[10-17] These nodes of information are potential sources of continuous disease surveillance.

Case in point, smart phones assisted in the 2010 Haiti Earthquake disaster relief by tracking population movements during cholera outbreaks;[18] reported on mosquito-borne Dengue virus to help predict epidemics;[19] helped educate and train first responders and clinicians;[20] and, leveraged social media activity to track outbreaks of syndromic influenza.[21] Indeed, a global biosurveillance effort must have an integrated response system. This manuscript presents an overview of an existing capability, the Global Biosurveillance Portal (G-BSP), which addresses these requirements and provides enhanced capabilities for the warfighter.

Background

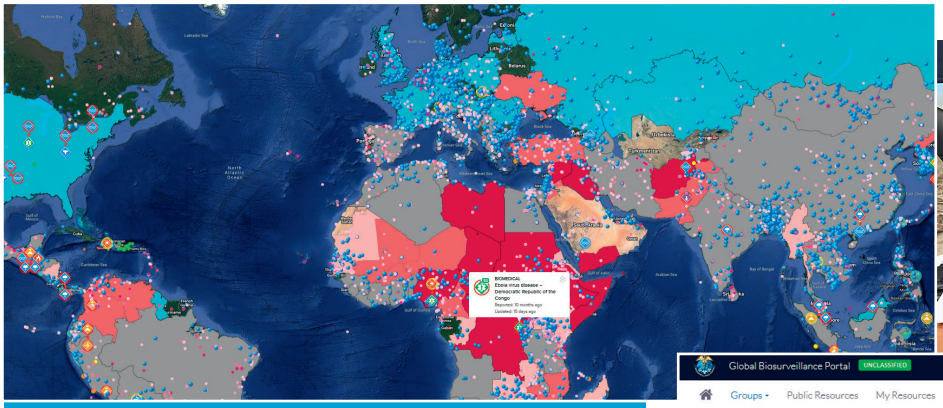
The G-BSP was originally designed to enhance biosecurity as a joint military capability. Biosecurity has been an essential element of national security for the United States. In 2012, the Joint Program Executive Office for Chemical, Biological, Radiological, Nuclear Defense (JPEO-CBRND) planned the G-BSP as a network of systems in reference to biosurveillance preparedness and a source of data sharing among critical strategic allies.[22]

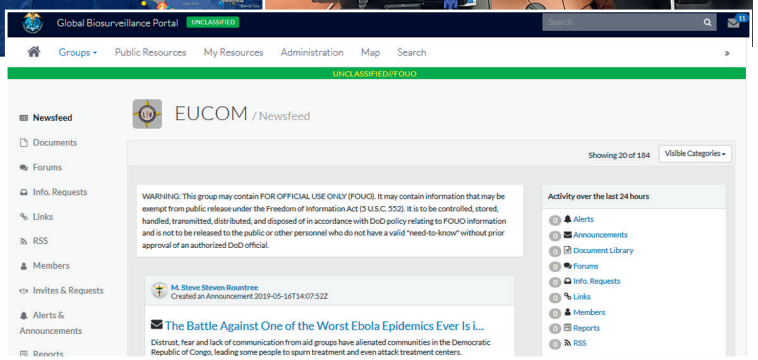
The G-BSP is a public health and medically focused system, but also supports an all-hazards environment. It was initially developed as part of the Joint United States Forces Korea Portal and Integrated Threat Recognition Advanced Technology Demonstration (JUPITR) and has been collaboratively designed by the Department of Defense, multiple inter-agencies, and international partners for operational employment. The G-BSP houses over 250+ One Health real-time data layers through existing partnerships with multiple organizations to include: Armed Forces Health Surveillance Branch; Centers for Disease Control and Prevention; Defense Threat Reduction Agency; Department of State; National Biosurveillance Integration Center (NBIC); National Center for Medical Intelligence; Pacific Disaster Center; and the World Health Organization (WHO). The G-BSP, a Program of Record sponsored by U.S. Special Operations Command (USSOCOM), intends to expand to the global community via Foreign Military Sales (FMS) and other mechanisms.

A primary objective is to provide situational awareness on EIDs and critical infrastructure for mission support. The G-BSP may be considered a "central data repository" for all things biosurveillance. It may be employed at the strategic, operational, and tactical levels. It is primarily employed in multiple communities across the public health and medical domain and operations centres across the world.

The G-BSP's Analyst Workbench will likely become a future capability that provides for potential correlations allowing for disease prediction and forecasting. The JPEO-CBRND is also working with the Department of Homeland Security (DHS) to integrate DHS's Bio-Feeds capability to allow users to have greater flexibility in searching for health surveillance data. The Analyst Workbench houses 30+ applications capable of analyzing and visualizing near real-time global epidemic and outbreak information from unique data sources, including point of need diagnostics. Analysts can determine the risk of pathogen introduction and disease spread, predict disease transmission, and analyse the impact of interventions. The G-BSP is used for all aspects of biosurveillance, situational awareness, collaboration, coordination and response and bio-mitigation while supporting the decision-making of the battlefield commander at the tactical, operational and strategic levels.

The following views, or snapshots of the G-BSP illustrate how the system is used to display geographically relevant biosurveillance data and information from the federal government, authenticated international partners and

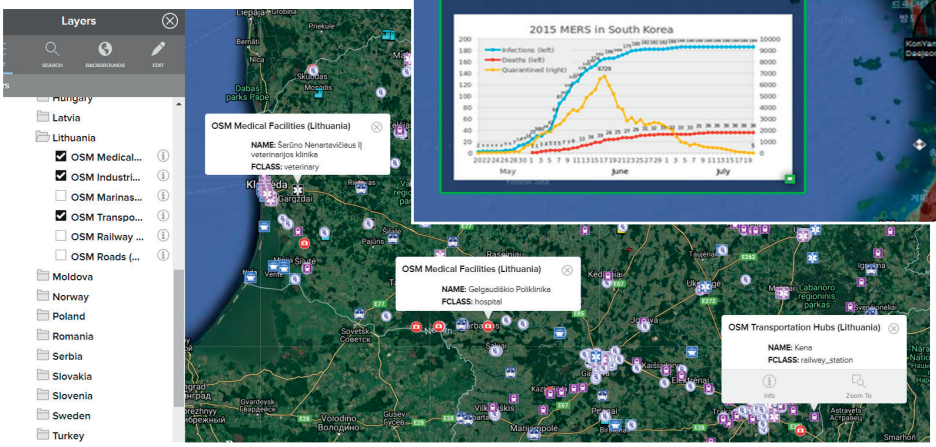


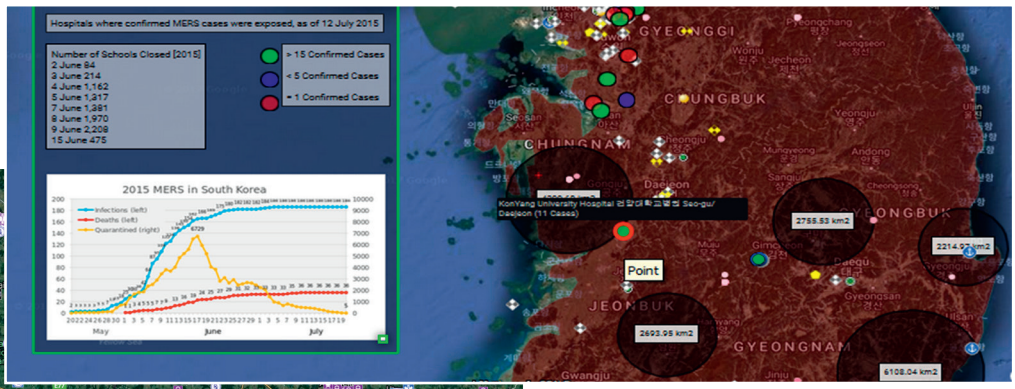


"The **Global Biosurveillance Portal** was originally designed to enhance **biosecurity** as a joint military capability."

ABOVE, CLOCKWISE: The G-BSP has been used in the past to provide situational awareness with regards to Ebola response efforts. The map shows humanitarian efforts in red/pink throughout the world; the Medical Corps personnel, from the U.S., Kuwait and Bangladesh, using the portal; the G-BSP is developed based on a group structure that allows organizations to share and collaborate at any level of government and among any combination of Partner Nations and Agencies.

BELOW: The Lithuania screenshot. The G-BSP has the capability to show infrastructure within a region of interest.





ABOVE: Republic of Korea Operational View – MERS (2015). This bookmark is illustrative of how the G-BSP could be used to depict information in a disease outbreak. It is an operational level view of the 2015 MERS outbreak in the Republic of Korea and shows location of hospitals, clinics, and number of confirmed cases of MERS.

non-government organizations *(See figures opposite page)*. Examples of significant disease events recently occurred in Asia and Africa during the West African Ebola and Middle Eastern Respiratory Syndrome (MERS) outbreaks.[23,24] At the direction of the U.S. White House, the Ebola Portal supported inter-agency and international response to the 2014 West Africa Ebola outbreak. Similarly, the G-BSP technology assisted in the public health emergency response to the 2015 Republic of Korea MERS outbreak. Additionally, the G-BSP platform has been instrumental in outbreak response training during several major international exercises involving 14 nations and over 60 organizations with over 25 scenarios (*e.g.*, anthrax, botulism, biowarfare, cholera, dengue, Ebola, MERS, plague, and refugee crisis). Some examples include: 2011-16 Able Response (Republic of Korea and Australia); 2015 Eagle Resolve (Kuwait and Gulf Cooperation Council); 2016 Eager Lion (USCENTCOM and Kingdom of Jordan); and 2017Ardent Sentry (USNORTHCOM).

Upon completion of these exercises, the G-BSP achieved: enhanced Biosurveillance as part of a Common Operating Picture (COP) and public health security; enhanced government and interagency bio-crisis coordination and response, including medical cooperation, information sharing, and communications; operator feedback loops for G-BSP improved development *(See figures above)*.

Discussion

Capability to rapidly and reliably detect current and future biothreats is crucial in biosurveillance strategies. Yet, data integration remains a difficult challenge within scientific and public health disciplines. Nonetheless, disease surveillance utilizing maps have been well known to illustrate geographic clusters of incident diseases and outbreaks.[25] These graphical platforms are effective communication and analytic tools for critical cues on future trends and predictive modelling.

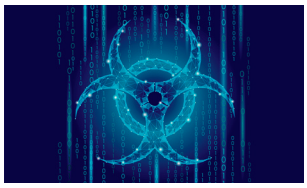
Therefore, infectious disease surveillance, detection and mitigation require a holistic approach to data collection, reporting, analysis and action. The complex interactions between human, animal, vector and environment through time and place conceptualizes the framework of biosurveillance. As technologies advance and improve diagnostic capabilities, disease preparedness and response require team collaboration among nations and nation-states, agencies and communities, individuals and experts, policy and decision makers, and user level input. However, this system of networking must constantly evolve with current research and technologies in order to be meaningful.[26]

Demonstration of an integrated global biosurveillance platform was proven with the G-BSP. However, some possible development directions can include a more sophisticated spatiotemporal algorithm using scan statistics for disease outbreak prediction.[27] One advantage of the G-BSP compared with other systems is its capability to integrate the military and civilian surveillance efforts and leverage existing systems into the data portal. Also, this platform can expand the user interface and analytic tools through an agile development process. Other capabilities to this technology include adaptable user interface with secure access to information. This biosurveillance portal is well known to inject multiple data sources with various agencies and nation-state players. Lastly, it is a real-time common platform for decision points and leader engagements. Further improvements include data extraction techniques and dual interface with mobile devices such as smart phone technologies. Future refinement in analytic predictive modelling is also a key determinant for successful outcomes. Nonetheless, this current capability for a sole source data repository can be leveraged for future biosurveillance techniques within the multi-domain operations on the battlefield.

The G-BSP provides an emerging technology solution for the warfighter that could be leveraged to enhance military-civilian operations in an asymmetric battlefield. Operator feedback indicates the G-BSP strongly enhanced situational awareness and collaboration, and ultimately helped to support a COP with respect to bio-crisis management and

medical cooperation. Operationally, the G-BSP can be inserted into future collaborative, interministerial and military-civilian engagements. The G-BSP pioneered surveillance and information sharing, communications-based backbone for public health and biothreat response. Additionally, the G-BSP served as the inject delivery tool developing multi-media artifacts and currently utilizes interoperable platforms such as Travax, a highly reliable online tool for travelers or the deployed warfighter.

In conclusion, the G-BSP is a One Health solution to a single source "central data repository" with proven web-based interoperability and applications, science and technology integration with multiple joint agencies, and an agile platform for future data integration. Key leader engagement and collaboration to support these technologies is essential. Future advancement in data collection and analytics that will detect, direct and decide the next disease outbreak will determine Soldier Health and World Health.



REFERENCES:

1 Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, et al.: Global trends in emerging infectious diseases. Nature 2008; 451: 990-93. doi:10.1038/nature06536.

2 Valdivia-Granda WA: Biosurveillance enterprise for operational awareness, a genomic-based approach for tracking pathogen virulence. Virulence 2013; 4(8): 745-51. doi: 10.4161/viru.26893.

3 Valdavia-Granda WA: Bioinformatics for biodefense; challenges and opportunities. Biosecur and Bioterror 2010; 8(1): 69-77; doi: 10.1089/bsp.2009.0024. Available at https://www.liebertpub.com/doi/full/10.1089/bsp.2009.0024; accessed March 22, 2019.

4 Ouagrham-Gormley SB, Vogel KM. The social context shaping bioweapons (non) proliferation. Biosecur and Bioterr 2010; 8(1): 9-24; doi: 10.1089/bsp.2009.0054.

5 Jonas O: Pandemic Risk, World Development Report. The World Bank 2013.

6 Mullan Z. The cost of Ebola. The Lancet 2015; 3(8); e423.

7 CDC. Estimated influenza illnesses, medical visits, and hospitalizations averted by vaccination. Available at https://www.cdc.gov/flu/about/burden-averted/index.htm; accessed March 25, 2019.

8 U.S. Department of Health and Human Services. National Health Security Strategy. Washington D.C.: U.S. Department of Health and Human Services.

9 World Health Organization. Strengthening health security by implementing the International Health Regulations (2005): WHO, 3rd edition.

10 Wang Y: More people have cell phones than toilets, U.N. study shows, Time March 25, 2013. Available at http://newsfeed.time.com/2013/03/25/more-people-have-cell-phones-than-toilets-u-n-study-shows/; accessed March 25, 2019.

11 Mobile Fact Sheet. Pew Research Center Internet and Technology February 5, 2018.

12 Smith A: U.S. smartphone use in 2015. Pew Research Center Internet & Technology 2015.

13 Smartphone vendor market share, 2018 Q3. IDC 2018. Available at http://www.idc.com/prodserv/smartphone-market-share.jsp; accessed April 1, 2019.

14 Global smartphone shipments forecast from 2010 to 2020 (in million units). Statista 2019. Available at http://www.statista.com/statistics/263441/global-smartphone-shipments-forecast/; accessed April 1, 2019.

15 Gajewski KN, Peterson AE, Chitale RA, Pavlin JA, Russell KL, Chretien JP: A review of evaluations of electronic event-based biosurveillance systems. PLOS ONE 2014; 9(10): e111222.

16 Generous N, Margevicius KJ, Taylor-McCabe KJ, Brown M, Daniel WB, Castro L, et al.: Selecting essential information for biosurveillance-a multi-criteria decision analysis.

17 Barboza P, Vaillant L, Le Strat Y, Hartley DM, Nelson NP, Mawudeku A, et al.: Factors influencing performance of internet-based biosurveillance systems used in epidemic intelligence for early detection of infectious diseases outbreaks.

18 Bengtsson L, Lu X, Thorson A, Garfield R, von Schreeb J: Improved Response to Disaster and Outbreaks by Tracking Population Movements with Mobile Phone Network Data: A Post-Earthquake Geospatial Study in Haiti. PLOS MEDICINE 2011; 8(8): e1001083.

19 Wesolowski A, Qureshi T, Boni MF, Sundsoy PR, Johansson MA, Rasheed SB, et al.: Impact of human mobility on the emergence of dengue epidemics in Pakistan. Proc Natl Acad Sci 2015; 112(38): 11887-92.

20 West DM, Valentini E: How Mobile Devices are Transforming Disaster Relief and Public Safety, Issues in Technology Innovation 2013.

21 Santillana M, Nguyen AT, Dredze M, Paul MJ, Nsoesie EO, Brownstein JS: Combining Search, Social Media, and Traditional Data Sources to Improve Influenza Surveillance. PLOS Computational Biology 2015; 11(10): e1004513.

22 Rhee C, Burkom H, Yoon CG, Stewart M, Elbert Y, Katz A, et al: Syndromic Surveillance System for Korea-US Joint Biosurveillance Portal: Design and Lessons Learned. Health Security 2016; 14(3): 152-60.

23 Kalra A, Kelkar D, Galwankar S, Papadimos TJ, Stawicki SP, Arquilla B, et al: The Emergence of Ebola as a Global Health Security Threat: From 'Lessons Learned' to Coordinated Multilateral Containment Efforts. J Glob Infect Dis 2014; 6(4): 164-177.

24 Korea Centers for Disease Control and Prevention. Middle East Respiratory Syndrome Coronavirus Outbreak in the Republic of Korea, 2015. Osong Public Health Res Perspect 2015; 6(4): 269-278.

25 Kettelhut VV, Vanschooneveld TC, McClay JC, Mercer DF, Fruhling A, Meza J: Empirical study on the impact of a tactical biosurveillance information visualization on users' situational awareness. Mil Med 2017; 182 (suppl 1): 322-29.

26 Chute CG: Biosurveillance, classification, and semantic health technologies. J Am Med Info Assoc 2008; 15(2): 172-3.

27 Kulldorff M, Heffernan R, Hartman J, Assuncao R, Mostashari F: A space-time permutation scan statistic for disease outbreak detection. PLOS MEDICINE 2005; 2(3): e59.

COLONEL PAUL KWON is currently the Director of the U.S. Army Medical Research Directorate – Georgia. He served as an Assistant Operations Officer; Water Purification Platoon Leader; and Supply Support Activities Platoon Leader; Chief of Paediatrics; and deployed to Operation Iraqi Freedom as Medical Chief in COB Speicher. He also served as Chief of Preventive and Occupational Medicine and later became the Director of the Preventive Medicine Branch and then the Medical Director, Sleep Research Lab at the Walter Reed Army Institute of Research prior to his current assignment.

MR BRENT BUTOWSKY is the Global Biosurveillance Portal (G-BSP) International Lead for the Joint Program Executive Office for Chemical, Biological, Radiological, and Nuclear Defense (JPEO-CBRND). He currently works with the United States Special Operations Command (USSOCOM) in Europe and Africa in support of global health security and with Foreign Partners in support of security cooperation. He is also leading efforts on G-BSP development in preparation for future collaborative opportunities with NATO Partner Nations. Mr Butowsky holds a degree in Program Management from the University of New Hampshire. He is a Certified Emergency Manager (CEM) and holds many qualifications in Defense Acquisition and Homeland Security.

LIEUTENANT COLONEL MICHAEL MCCOWN is currently the Deputy Director of the US Army Medical Research Directorate-Georgia. He served multiple years in Special Operations Forces (SOF) and SOF-supported missions with his most recent assignment at NATO Deployment Health Surveillance Capability (DHSC).